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Revised HYDAS Calibration Estimates for Data Acquired Between May 1987 and February 1989

by

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Abstract

The procedures used to correct observed errors in HYDAS calibration estimates, for the period from May 1987 to February 1989, are described. Also, the origin of these errors, some calibration theory, and the adjusted calibration estimates are presented.

Résumé

On présente ici la marche suivie pour corriger les erreurs observées dans les estimations d'étalonnage du Système d'acquisition de données hydroacoustiques (HYDAS). On expose également l'origine de ces erreurs, une théorie d'étalonnage et les estimations corrigées.

Introduction

Acoustic surveys for biomass estimation of fish populations have been carried out using HYDAS (Stevens 1986), since the late 1970's, by the Newfoundland Region of the Department of Fisheries and Oceans.

With the increasing use of hydroacoustic estimates in assessment of fish, efforts are ongoing to improve the accuracy of HYDAS calibrations. One recent result of this work has been the discovery of some errors in the calibration estimates, which were used to process hydroacoustic data acquired between May 1987 and February 1989. Twelve acoustic survey results (16 datasets) are affected.

The purpose of this paper is to document these errors, report the corrected estimates and outline the scheme (agreed upon by the affected researchers) used to adjust previously reported biomass estimates.

Background

The calibration technique we used is generally known as calibration against a standard hydrophone/projector. In this technique the transmit (Source Level - SLDB) and receive (Receive Sensitivity - RSDB) components of the system calibration are measured separately. The towed body containing the survey transducer is mounted on top of a 5 metre structural frame and the standard hydrophone/projector is mounted in a remotely controlled X-Y positioning mechanism at the bottom of the frame. Calibrations were normally performed over the side of the ship in St. John's harbor both prior to and immediately following a survey.

System calibration incorporates a method which is essentially an accounting of power losses and gains through various system components. The transmission loss (TL) is a function of the range (R) from the transducer face to the hydrophone. At a range of 5 metres, TL is about 14 dB with a sensitivity of approximately 0.02 dB/centimetre. As TL is a term in both the SLDB and RSDB estimates, an error of 1 centimetre in R results in a system calibration (CALDB) error of 0.04 dB.

A new calibration frame (NORDCO - Rev. B) was put into service in May 1987. At that time an error was made in measuring the distance from the transducer face to the hydrophone. This error went undetected until July 1989. Consequently, the HYDAS Calibration Forms filed for 16 GADUS ATLANTICA datasets require adjustment (see Table 1).

Results

The distance measurement error resulted in an underestimate of CALDB of either 1.14 dB or 1.417 dB, depending on the towed body and transducer used. Also, some minor errors (i.e. computation and transcription errors) were uncovered during this examination of the original datasets and were incorporated in the corrections. Table 1 reports the original CALDB estimates and the corrected SLDB, RSDB and CALDB estimates for all the calibration datasets acquired during the May 1987 to February 1989 period.

Adjustments could have been applied directly to the final biomass estimates from each acquired dataset but a closer look at the underlying components (SLDB and RSDB estimates) showed that several corrected SLDB estimates were too high to be credible. The largest corrected SLDB estimate was for GADUS ATLANTICA #158 at 126.7 dB (Dataset #23, Table 1), while the highest SLDB estimate obtained with a comparable system configuration was 125.3 dB (GADUS ATLANTICA #173, fall 1989). We concluded that the calibration estimates generated during the period in question were too "noisy." While other sources of error were involved, most of the "noise" can be attributed to the deficiency of "free field conditions" which was caused by the use of continuous carrier signals as opposed to pulsed carrier signals.

Rather than an arbitrary rejection of outlying calibrations, the approach adopted was to calculate means via a two stage process:

Stage 1: Calculate a mean CALDB estimate (Intermediate CALDB estimate) using the Corrected CALDB estimates where multiple calibrations were performed during a period not exceeding two days.

Stage 2: Using the Intermediate CALDB estimates derived in Stage 1, calculate a mean CALDB estimate (Adjusted CALDB estimate) where a series of calibrations were performed with the same HYDAS equipment configuration.

Note that all means were calculated by first converting the original decibel (dB) values to equivalent power ratios. Then the mean ratios were calculated and expressed as decibel values.

The datasets in Table 1 are grouped by rows to indicate the Corrected CALDB estimates used to compute the Intermediate CALDB estimates. Table 2 reports the Original Analysis CALDB estimates, the results of the Stage 1 calculations (Intermediate CALDB estimates), the results of the Stage 2 calculations (Adjusted CALDB estimates) and the required biomass adjustments (Biomass Adjustment). The datasets in Table 2 are grouped by rows to indicate the Intermediate CALDB estimates used to compute the Adjusted CALDB estimates. Each Intermediate CALDB estimate in a grouping is considered an independent estimate of the system calibration for a particular HYDAS equipment configuration. Note that an underestimate of CALDB leads to an overestimate of biomass.

Acknowledgments

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Bibliography

Stevens, C.R. 1986. A hydroacoustic data acquisition system HYDAS for the collection of acoustic data from fish stocks. Can. Tech. Rep. Fish. Aquat. Sci. 1520: v + 73 p.

Table 1. Original and corrected estimates for all calibration dataset acquired from May 1987 to February 1989.

Dataset Number	Trip Number	Calibration Date	Original ALDB	Corrected Estimates RSDB	SLDB	CALDB
1	137	14 May 87	27.80	-90.86	119.63	28.77
2	138-A	4 Jun 87	31.70	-86.70	119.57	32.87
3	138-A	4 Jun 87	32.10	-86.69	119.86	33.17
4	138-B	11 Jun 87	67.10	-50.89	121.61	70.72
5	139	24 Jun 87	68.30	-52.23	121.90	69.67
6	139	25 Jun 87	68.60	-51.65	121.61	69.96
7	141	23 Jul 87	69.80	-51.57	122.79	71.22
8	144	2 Oct 87	70.80	-50.80	122.96	72.16
9	144	8 Oct 87	69.40	-52.07	122.96	70.89
10	149	2 Feb 88	58.10	-59.62	121.80	62.18
11	149	2 Feb 88	58.90	-59.23	122.17	62.95
12	151-A	12 May 88	54.80	-68.83	125.12	56.29
13	151-B	25 May 88	55.90	-66.60	123.93	57.33
14	152	2 Jun 88	57.10	-67.71	126.17	58.46
15	152	3 Jun 88	55.83	-67.46	124.71	57.25
16	153	20 Jun 88	58.19	-66.99	126.60	59.61
17	153	21 Jun 88	53.95	-68.34	123.71	55.37
18	155-A	30 Jul 88	49.09	-75.28	125.80	50.52
19	155-A	30 Jul 88	49.91	-74.56	125.89	51.33
20	155-A	30 Jul 88	49.73	-74.74	125.89	51.15
21	155-B	15 Aug 88	51.36	-73.56	126.64	53.09
22	158-A	7 Oct 88	52.30	-71.49	125.21	53.72
23	158-B	25 Oct 88	54.40	-70.89	126.71	55.82
24	163	2 Feb 89	51.66	-72.23	125.31	53.08
25	163	2 Feb 89	50.80	-72.69	124.91	52.22
26	163	3 Feb 89	50.60	-72.79	124.81	52.02
27	163	3 Feb 89	52.90	-70.49	124.81	54.32

Table 2. Intermediate and Adjusted Estimates for Discrete Datasets.

Discrete Dataset	Original Analysis CALDB (1)	Intermediate CALDB	Sample Size (2)	Adjusted CALDB (3)	Biomass Adjustment
137	32.00	28.77	1	31.40	+14.8%
138-A	n/a	33.02	2	31.40	n/a
138-B	n/a	70.72	1	70.72	n/a
139	68.60	69.82	2	69.82	-24.5%
141	n/a	71.22	1	71.22	n/a
144	70.80	72.16	1	71.57	-16.3%
144	70.80	70.89	1	71.57	-16.3%
149	n/a	62.58	2	62.58	n/a
151-A	55.90	56.29	1	56.29	- 8.6%
151-B	57.10	57.33	1	57.75	-13.9%
152	n/a	57.90	2	57.75	n/a
153	58.20	57.99	2	57.75	+10.9%
155-A	n/a	51.01	3	53.61	n/a
155-B	n/a	53.09	1	53.61	n/a
158-A	52.30	53.72	1	53.61	-26.0%
158-B	52.30	55.82	1	53.61	-26.0%
163	n/a	53.01	4	53.61	n/a

Notes: (1) Original Analysis CALDB estimates that were used to conduct biomass assessments.

(2) Number of calibrations used to compute the Intermediate CALDB estimates.

(3) Adjusted CALDB estimates were computed using Intermediate CALDB estimates for the same HYDAS equipment configuration.